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"Great-granddaddy, 1914," 1988

M. Lynne Kesel, DVM

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Coverage of sixty core veterinary medical journals by ten indexing and abstracting tools

R. J. Veenstra, MA, and J. C. Wright, DVM, PhD

Summary: *Ten indexing and abstracting reference sources were examined for their coverage of 60 core veterinary medical journals. The costs of the indexes also were compared. Coverage of the 60 core veterinary journals ranged from 8 of 60 journals by* Current Contents—Life Sciences *to 57 of 60 by* Index Veterinarius. *Based on yearly costs, format, and coverage of the 60 core veterinary journals,* Small Animal Practice *and the 2 editions of* Veterinary Reference Service *were determined to be the most useful for private practitioners. The* Index Veterinarius *gives the most complete coverage of the core veterinary journals for veterinary research workers who have access to a library.*

The literature of the veterinary medical field is vast and encompasses many specialized publications including journals, monographs, association proceedings, newsletters, and government publications. To provide efficient access to this complex literature, various indexing and abstracting reference tools have been developed. Although most of these reference tools are available in print, some have similar computer versions. A few reference tools or services such as the CONSULTANT database are exclusively available on-line. The indexing and abstracting tools to veterinary medicine vary considerably in accessibility and coverage; however, there is a lack of quantitative information about their important differences. The following reference tools were evaluated for their coverage of 60 core veterinary medical journals: *Bibliography of Agriculture, Biological Abstracts, Capsule Report, Current Contents—Agriculture, Current Contents—Life Sciences, Index Medicus, Index Veterinarius, Quarterly Index, Small Animal Practice,* and *Veterinary Reference Service* large animal and pet animal editions. (*See* Appendix for a brief description of each.)

From the Health Science Libraries, Hartford Hospital, Hartford, CT 06106 (Veenstra) and the Department of Pathobiology, College of Veterinary Medicine, Auburn University, AL 36849 (Wright).

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Knowing more about the characteristics of specific indexes will improve the effectiveness and precision of information retrieval by veterinarians and veterinary researcher workers. Veterinarians have a large number of reference tools from which to select. These range from a few broad multidisciplinary tools such as *Bibliography of Agriculture* or *Biological Abstracts* that provide international coverage of thousands of animal-related publications, to more specialized and limited current awareness newsletters such as *Capsule Report* or *Small Animal Practice*.

The selection of specific printed indexing and abstracting reference tools to be included was based mainly on the list compiled by Boyd[1] of the Veterinary Serials Committee, Veterinary Medical Libraries Section, Medical Library Association. He recently published an updated version of the basic list of indexing and abstracting tools for veterinary medical literature. Most of the tools identified in the list were evaluated by us. However, to avoid duplication, only the most comprehensive tool, *Index Veterinarius*, was selected for a comparison of journal coverage. The only other omission from the list compiled by Boyd is the *Science Citation Index*. This important title was omitted because some of the data relating to the selection of the 60 core veterinary medical journals was derived from the citation data of the *Science Citation Index*. Also, the *Bibliography of Reproduction* was not included, because a list of journals cited was not available. Two newer reference tools gaining acceptance with veterinarians, *Small Animal Practice* and *Capsule Report*, also were included in the study.

All of the indexing and abstracting reference tools were evaluated for coverage of the core veterinary medical journals by examining a list of their journal coverage. Such lists of journal coverage typically are included as part of the indexing and abstracting tools, although some lists must be purchased independently, or may be obtained only on request. Only printed indexing and abstracting sources were compared for journal coverage. However, many of the printed tools also have similar on-line computer versions available, as described by Nielsen.[2] The coverage policies of reference

Table 1—Coverage of 10 indexing and abstracting tools of the 60 core veterinary medical journals

Journal	Bibliographic tool									
	BIB AG	BIO AB	CAPRP	CC AG	CC LS	IMED	IVET	QRTI	SAP	VRS
Acta Veterinaria Scandinavica	–	+	–	+	–	+	–	–	+	+
Advances in Veterinary Science and Comparative Medicine	–	+	–	–	–	+	–	–	–	–
American Journal of Veterinary Research	–	+	–	+	–	+	+	+	+	–
Animal Genetics	–	+	–	+	–	+	+	–	–	–
Animal Production	+	+	–	+	–	–	+	–	–	+
Animal Reproduction Science	–	–	–	+	–	–	+	–	–	+
Australian Veterinary Journal	–	+	+	+	–	+	+	–	+	+
Australian Veterinary Practitioner	–	+	–	+	–	–	+	–	+	+
Avian Diseases	–	+	–	+	–	+	+	–	–	–
Avian Pathology	–	+	–	+	–	–	+	–	–	–
Bovine Practitioner	–	+	–	–	–	–	–	–	–	+
British Veterinary Journal	–	+	+	+	–	+	+	–	+	+
California Veterinarian	–	–	+	–	–	–	+	+	+	+
Canadian Journal of Veterinary Research	–	+	–	+	–	+	+	–	+	–
Canadian Veterinary Journal	–	+	+	+	–	–	+	+	+	+
Companion Animal Practice	+	+	+	+	–	–	+	+	+	–
Comparative Immunology Microbiology and Infectious Diseases	–	+	–	+	–	+	+	–	+	–
Compendium on Continuing Education for the Practicing Veterinarian	+	–	+	+	–	–	+	+	+	+
Cornell Veterinarian	–	+	–	+	–	+	+	+	+	+
Equine Practice	+	+	–	–	–	–	+	–	–	+
Equine Veterinary Journal	–	+	–	+	–	+	+	–	–	+
In Practice	–	+	+	–	–	–	+	–	+	–
Irish Veterinary Journal	–	–	–	+	–	–	+	–	+	–
Journal of Animal Science	+	+	–	+	–	+	+	–	–	+
Journal of Comparative Pathology	–	+	–	+	+	+	+	–	+	+
Journal of Dairy Science	–	+	–	+	–	+	+	–	–	+
Journal of Medical Primatology	–	+	–	+	+	–	+	–	–	–
Journal of Reproduction and Fertility	–	+	–	–	+	+	+	–	–	–
Journal of Small Animal Practice	+	+	–	+	–	–	+	+	+	+
Journal of the American Animal Hospital Association	–	+	+	+	–	–	+	+	+	+
Journal of the American Veterinary Medical Association	+	+	+	+	–	+	+	+	+	+
Journal of the South African Veterinary Association	–	–	–	+	–	+	+	–	+	+
Journal of Veterinary Internal Medicine	–	–	+	+	–	–	+	+	+	–
Journal of Veterinary Medicine, Series A: Animal Physiology, Pathology, and Clinical Veterinary Medicine	–	+	–	+	–	–	+	–	–	–
Journal of Veterinary Medicine, Series B: Infectious Diseases, Immunology, Food Hygiene, Veterinary Public Health	–	+	–	+	–	–	+	–	–	–
Journal of Veterinary Pharmacology and Therapeutics	+	+	–	+	–	+	+	–	+	+
Journal of Wildlife Diseases	+	+	–	+	–	+	+	–	–	–
Journal of Zoo Animal Medicine	–	+	–	+	–	–	+	–	–	–
Laboratory Animal Science	–	+	–	+	+	+	+	–	–	+
Laboratory Animals	+	+	–	+	+	+	+	–	–	–
New Zealand Veterinary Journal	–	–	–	+	–	–	+	–	+	+
Poultry Science	+	+	–	+	–	+	+	–	–	–
Preventive Veterinary Medicine	–	+	–	+	–	–	+	–	–	–
Research in Veterinary Science	–	–	+	+	–	+	+	–	+	+
Theriogenology	–	+	–	+	–	–	+	–	–	–
Tropical Animal Health and Production	–	+	–	+	–	+	+	–	–	–
Veterinary and Human Toxicology	–	+	–	+	–	+	+	–	+	+
Veterinary Clinics of North America: Equine Practice	+	–	–	+	–	+	+	–	–	–
Veterinary Clinics of North America: Food Animal Practice	+	–	–	+	–	+	+	–	–	–
Veterinary Clinics of North America: Small Animal Practice	+	+	–	+	–	+	+	–	–	–
Veterinary Immunology and Immunopathology	–	+	–	+	+	+	+	–	–	–
Veterinary Medicine	+	+	+	+	–	+	+	+	+	+
Veterinary Microbiology	–	+	–	+	+	+	+	–	–	+
Veterinary Parasitology	–	+	–	+	–	+	+	–	–	+
Veterinary Pathology	+	+	+	+	+	+	+	+	+	+
Veterinary Quarterly	–	+	–	+	–	+	+	–	+	+
Veterinary Radiology	–	+	–	+	–	–	+	+	–	+
Veterinary Record	+	+	–	+	–	+	+	–	+	+
Veterinary Research Communications	–	+	–	+	–	+	+	–	+	+
Veterinary Surgery	+	+	–	+	–	–	+	+	+	+

BIB AG = *Bibliography of Agriculture*; BIO AB = *Biological Abstracts*; CAPRP = *Capsule Report*; CC AG = *Current Contents—Agriculture*; CC LS = *Current Contents—Life Sciences*; I MED = *Index Medicus*; I VET = *Index Veterinarius*; QRT I = *Quarterly Index*; SAP = *Small Animal Practice*; VRS = *Veterinary Reference Service*.

tools, however, are constantly adapting to the producers' perception of the needs of users. To allow for such changes, recent issues of reference tools also were examined to verify current journal coverage. It has become common practice for producers of reference tools to include sporadically selective coverage of other periodicals. Lists of periodicals with sporadic coverage generally are not available. Therefore, sporadic journal coverage of an index or abstract was excluded for consideration.

The selection of the 60 core veterinary medical journals was based on results of several studies: titles listed in Boyd's basic list of veterinary medical serials,[1] a 1986 journal citation report,[3] Garfield's citation study of 35 veterinary journals,[4] a survey of literature found in veterinary practices,[5] an analysis of journal citation frequency in the CONSULTANT database used for computer-assisted veterinary diagnosis,[6] and a journal-use study in a university veterinary medical library.[7] Each of these references identified important journals. English language journals that appeared repeatedly were identified and compiled into a list of 60 core journals representative of veterinary medical literature that could be used as a method to determine depth of indexing and abstracting reference tools. Table 1 is an alphabetic listing of 60 core veterinary journals and the indexing and abstracting sources that regularly cover the articles in each journal.

Previous comparisons of various indexing and abstracting tools have identified numerous types of criteria in addition to those reported here. Singh[8] proposed evaluations based on the numbers and type of indexing points, amount and completeness of bibliographic information, and types and number of publications covered. He also examined the depth of indexing and the types of abstracting. Lancaster[9] compared various indexes based on the amount of effort a user must spend to find a specified number of relevant citations. Lancaster also identified novelty as another important aspect of indexes. He defined novelty as the ability of the indexing or abstracting tool to provide an awareness of new information for a user, not simply to provide access to information with which a user is already familiar. Drage[10] emphasized the importance of user preference to indexing and abstracting services. He indicated that the general appearance of an index has a consequent physical impact on the individual user and concluded that this impact has a major role in the ease of use of a specific tool and the level of precision for information retrieved. Marsh[11] recently studied publication delay, or the lag time between an article in the area of "bioethics" being published and its citation appearing in the indexes. He concluded that delays are related to several factors, including frequency of publication. Some articles in similar indexes appeared as much as a year apart.

The ability of an index to cover journals in the veterinary medical literature is of primary importance to practicing veterinarians. There are many other valid criteria that may be used to examine indexing tools. The ease of use, novelty of information obtained, and lag time of citations appearing may be areas for future study. However, unless the indexing or abstracting tool covers desirable journals, all other considerations are of minimal importance.

Coverage of the 60 core veterinary journals by the 10 indexing and abstracting tools is seen in Table 1. The highest coverage is provided by *Index Veterinarius* (57 of 60 journals), and the lowest coverage is provided by *Current Contents—Life Sciences* (8 of 60 journals). The indexing tool with the second highest coverage of the core veterinary journals is *Current Contents—Agriculture* (53 of 60); similar to *Index Veterinarius*, it does not provide abstracts. Yearly costs ranged from $3,285 for *Bibliogical Abstracts* to $36 for *Small Animal Practice* (Table 2). *Biological Abstracts*, at a cost of over $3,000, is found only in research libraries; BIOSIS, an on-line version of this tool, may be accessed more economically through a vendor such as DIALOG.

There is considerable journal coverage overlap of the various tools (Table 1). However, journal coverage overlap may not necessarily mean journal article overlap, defined by Poyer[12] as "the same journal article being indexed by 2 or more services." Journal coverage by an index or abstract tool is seldom absolute and is more a matter of degree. One tool may provide access to every article, but then not provide access to other areas (eg, letters to the editor, editorials, or abstracts of meetings). Another tool may cover only 1 or 2 articles that are of interest to the primary audience. *Index Veterinarius* and *Biological Abstracts* approach cover-to-cover indexing for thousands of animal-related journals, although they do provide less complete depth of indexing for some of the non-English publications or for entries of minimal relevance. *Small Animal Practice* indexes 30 of the core veterinary journals, but omits many of the ar-

Table 2—Costs and core veterinary journals covered by 10 indexing and abstracting tools

Bibliographic tool	Yearly cost	Core veterinary journals covered
Bibliography of Agriculture	$ 515	18
Biological Abstracts	3,285	49
Capsule Report	47.50	13
Current Contents—Agriculture	283	53
Current Contents—Life Sciences	283	8
Index Medicus	183	36
Index Veterinarius	500	57
Quarterly Index	85	14
Small Animal Practice	36	30
Veterinary Reference Service[a]	98	34

[a]Cost for the *Veterinary Reference Service* is for each edition (equine/food animal and small animal). Core veterinary journals covered for *Veterinary Reference Service* are the journals covered by both editions.

ticles that might be useful to veterinarians. In contrast, *Quarterly Index* provides access to every article in every journal that it covers, although it covers only 14 of the core list. *Veterinary Reference Service* and both issues of *Current Contents* also provide complete coverage of articles.

Each publisher usually compiles a list of key terms for subject headings in the arrangement of their index. This allows them to better serve the needs of their primary audience. Seldom are these lists of controlled subject terms made available to the public; exceptions are *Biological Abstracts* and *Index Medicus*. This is unfortunate, because the availability of a thesaurus of subject headings makes an index easier to use and improves effectiveness.

A survey of British veterinarians[5] indicated that they had 1 or 2 journals and 11 to 30 books in their private libraries. Because private veterinary practitioners also have limited access to a veterinary library, indexing tools that also provide abstracts are the most useful. Of the 10 bibliographic tools reported here, 6 provide this type of service: *Bibliography of Agriculture, Biological Abstracts, Capsule Report, Quarterly Index, Small Animal Practice,* and *Veterinary Reference Service*. However, abstracts may have considerable variation. The typical author abstract is informative and provides a brief summary of the article, written in the style and length established by the journal. Abstracts found in *Biological Abstracts* are of this type. Abstracts provided by the *Veterinary Reference Service, Quarterly Index,* and *Capsule Report* are written by a specialist in the field and usually comprise between 200 and 500 words, and provide more details about the article. Often this type of abstract will enable busy veterinarians to defer reading the original paper.

Small Animal Practice and *Capsule Report* newsletters offer the most critical or evaluative abstracts. In addition to providing summaries of selected papers, specialists place a value judgement on the article. Specialists may analyze the methods or the data analysis, and also may offer alternative conclusions. *Small Animal Practice* gives its evaluation in the Comments section immediately following the abstract, whereas *Capsule Report* includes critical comments within the text of the abstract. Critical abstracts are especially helpful to recently graduated veterinarians, because articles are placed in a broader perspective.

Appendix

The 10 indexing and abstracting tools evaluated, plus 2 others not evaluated, are described.

Bibliography of Agriculture is a monthly index to the literature of agriculture and allied sciences based on indexing and cataloging records found in AGRICOLA (Agricultural On-Line Access), the computerized bibliographic data files distributed by the National Agricultural Library. This abstracting service covers citations to journal articles, pamphlets, books, new serials, government documents, special reports, and other materials. Items from about 43 languages are represented. Annual issues are available. Over 5,000 journal titles are covered; however, many of the entries are for the subject of botany. (Cost $515/yr. Oryx Press, 2214 N Central at Encanto, Phoenix, AZ 85004.)

Biological Abstracts attempts to report worldwide research in the life sciences. In addition to the subject and author access points, there is a unique generic index that gives access according to genus and species names. Generic access may be especially useful for veterinarians who treat exotic animals. The abstracts are arranged within 84 major concept headings. This is a "key word in context" index that is published semimonthly with semiannual cumulative issues. It is the principle abstracting journal for the subject of biology (over 9,000 titles), with considerable coverage of veterinary literature. Related on-line files are available as BIOSIS (Cost of printed service $3,285/yr. Biosciences Information Services, 2100 Arch St, Philadelphia, PA 19103-1399.)

Capsule Report is a 4-page, monthly abstracting newsletter for people interested in current topics and trends in the field of veterinary medicine. Edited by William L. Collins, DVM, with an annual index issue, this service selectively covers about 56 veterinary related periodicals, newsletters, regional publications, reports, and seminars. Descriptive abstracts with evaluative comments written by specialists vary in length from 50 to about 400 words. Especially relevant details are highlighted with bold print for ease of use. (Cost $47.50/yr. 26942 Preciados, Mission Viejo, CA 92691.)

Current Contents—Agriculture, Biology & Environmental Sciences is one of several in the weekly current awareness series. This tool publishes tables of contents from the newest issues of relevant journals. Users may scan through the titles, or use a key word index or author index to locate entries. The index covers about 1,200 periodicals. A modified version is available on-line as SCISEARCH. The publisher also provides a document delivery service for articles by mail and telefax, or one may use the Author and Address Directory for requesting reprints. This edition of the *Current Contents* has the most complete coverage of the animal sciences. (Cost $283/yr. Institute for Scientific Information, 3501 Market St, Philadelphia, PA 19104.)

Current Contents—Life Sciences is identical in format to the other parts of this service. The Life Sciences section has limited coverage of the animal science journals. However, it has been found that veterinary researchers also rely heavily on many of the nonveterinary basic medical journals that are covered in this current awareness tool. (Cost

$283/yr. Institute for Scientific Information, 3501 Market St, Philadelphia, PA 19104.)

Index Medicus began as a listing of the holdings of the Surgeon General's library in 1865. Published since 1879 under various forms, this index continues as a cornerstone in medical literature and is now produced by the National Library of Medicine. Issues are published monthly and there is an annual *Cumulated Index Medicus*. Over 2,750 international journals in about 42 languages are indexed completely or selectively. In addition to coverage of the health sciences, there are entries for articles related to biology, entomology, chemistry, veterinary medicine, and zoology. Access may be by medical subject headings and by author(s). An especially useful section is the *Bibliography of Medical Reviews*. Modified versions of *Index Medicus* with a large percentage of abstracts not found in the printed format are available on-line or in CD-ROM through various vendors. (Cost of printed source $163/yr. Superintendent of Documents, US Government Printing Office, Washington, DC 20402.)

Index Veterinarius is perhaps the most widely known of the specialized veterinary indexes. Published in monthly issues, this tool provides comprehensive coverage of the world's veterinary literature by providing access to information in approximately 1,300 journals in 40 languages. Books, conference proceedings, theses, and dissertations also are covered. Coverage of the journals may be cover-to-cover or selective. Articles concerning cattle, horses, sheep, goats, pigs, poultry, cats, dogs, cage birds, wildlife, exotic animals, laboratory animals, and fish are frequently included. Annual cumulations are available. A related on-line version is commercially available. (Cost of printed index varies; approximately $500/yr. CAB International, Farnham House, Farnham Royal, Slough SL2 3BN, United Kingdom.)

Quarterly Index: Information Access for the Small Animal Practitioner provides the small animal practitioner with access to the information in 18 veterinary journals. There are original abstracts written by veterinarians for many of the entries, and every article, case report, and letter is accessible in the periodicals covered. The format of the index is unique and is arranged by periodical title. Articles are presented or abstracted in the order in which they appear in the journal. Users may browse through the index as if they were browsing through the actual journal. Citations refer the reader to the exact pages for the full article. Author and subject indexing is included, and the index has a cumulated annual edition. Of special interest is a "highlights" sheet arranged by subject, which draws attention to high-appeal articles. A document delivery service also is offered, and an on-line version of this index is available. The on-line version is designed specifically for inexperienced searchers. Built into the system is a revolutionary program that assists users by automatically identifying and searching for possible synonyms, thus lowering the cost and improving the relevance of the information obtained. (Cost of printed index $65/yr. Veterinary Interface, 5679 Claribel Rd, Oakdale, CA 95361.)

Small Animal Abstracts, although not evaluated by us, deserves mention. This too, provides quarterly abstracts concerning dogs, cats, and smaller pets. Designed as a low cost alternative for the small animal practitioner, this source is compiled from relevant data in the much more extensive *Veterinary Bulletin*. Cumulative subject and author index are included, and approximately 1,500 abstracts are published yearly. (Cost of printed index varies; approximately $96/yr. CAB International, Farnham House, Farnham Royal, Slough SL2 3BN, United Kingdom.)

Small Animal Practice had its first issue published in January 1988. The goal of this 6-page newsletter is to survey and evaluate current developments in small animal medicine and surgery for immediate use in clinical practice. This abstracting newsletter selectively covers about 80 periodicals (some international in scope), proceedings, and regional publications. The editor, Kyle G. Braund, DVM, emphasizes the coverage of new and old diseases, new surgical methods and treatments, and diagnostic techniques. A glossy 2-color publication with bold headings, the newsletter's subject groupings and overview list called "In This Issue" makes it easy to use. (Cost $36/yr. Williams and Wilkins, 428 E Preston St, Baltimore, MD 21202.)

Veterinary Bulletin, although not evaluated by us, also deserves mention. It provides abstracts for about 40% of entries found in its companion tool, the *Index Veterinarius*. The monthly issues of the bulletin include the abstracts, and author and subject indexes. Unlike the other tools described, there are about a dozen review articles on veterinary subjects included as part of this service. (Cost varies; approximately $377/yr. CAB International, Farnham House, Farnham Royal, Slough SL2 3BN, United Kingdom.)

Veterinary Reference Service: Clinical Abstract Service—Small Animal Edition and *Large Animal Edition* provide lengthy abstract summaries of the articles in about 40 journals. Articles are arranged by animal type. The general section of the small animal edition often includes articles on cage birds. In addition to the monthly loose leaf sheets (about 32 pages), there is an annotated index provided for each monthly issue. The cumulative annotated index can be quickly and easily scanned for relevant articles. (Cost $98/yr each. American Veterinary Publications Inc, 5782 Thornwood Dr, Goleta, CA 93117-3896; 1-800-235-6947.)

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Veterinary and nonveterinary costs of disease in 29 California dairies participating in the National Animal Health Monitoring System from 1988 to 1989

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Summary: *Twenty-nine California dairy herds were studied over a 12-month period from 1988 to 1989 as part of the National Animal Health Monitoring System. Monthly interviews administered to dairy producers were used to measure the costs of all health-related expenditures and disease incidence in these herds. Of the total $1,523,558 reported, $1,355,467 (89%) was attributed to cost of disease events and $168,091 (11%) to cost of disease prevention. Most (78%) of the cost of disease events was attributable to death and culling losses. Veterinary services accounted for only $54,099 (4%) of total costs, 64% of which was used for disease prevention, compared with 36% for disease treatment. Udder disease was the most costly category of diseases reported at an average of $49.85/head at risk annually, followed by reproductive problems at $38.05. Through the use of sampling strategies less biased than those used in other surveys, the National Animal Health Monitoring System is designed to provide statistically-valid estimates of disease incidence and costs across broad geographic areas, potentially benefiting all those interested in the economics of livestock diseases in the United States.*

The National Animal Health Monitoring System (NAHMS) is designed to measure the incidence and cost of health-related events in livestock and poultry species. The NAHMS is coordinated by the USDA Animal and Plant Health Inspection Service (APHIS), Veterinary Services (VS) and represents a new direction from the agency's traditionally regulatory role. The history, organization, and potential benefits of the NAHMS program have been reviewed.[1-3] Through commitment toward an accurate assessment of the number of animals under observation and careful record-keeping of disease events and costs, incidence rates and costs per head can be determined from NAHMS data. These measures are useful to producers, veterinary practitioners, and government agencies attempting to reduce the economic impact of livestock diseases.

As economic pressures continue to increase, livestock producers are beginning to demand documented return on their investment for veterinary services; some of these needs can be fulfilled by NAHMS.[2] The NAHMS may also prove to be a valuable format for evaluating the broad health impact of management changes, possibly leading to cost-optimized production strategies.[2] The NAHMS differs from most livestock economic research in that attempts are made to study only herds that have been recruited through statistically valid sampling schemes.[1] To the extent that this helps reduce bias, the results of NAHMS surveys can be extrapolated to provide reasonable estimates for defined geographic areas. With the experience of several statewide dairy cattle NAHMS surveys over the past few years, NAHMS is now evolving into a single national program.[4] California has participated in NAHMS since 1983, thus far completing 3 dairy cattle surveys. The purpose of the study reported here was to use the NAHMS program to determine all obvious disease-related expenditures and cost components associated with veterinary services in 29 California dairy herds over a 12-month period from 1988 to 1989. Comparisons have been made between the amount and type of veterinary utilization indicated during initial producer interviews and that subsequently measured in the same herds during the study.

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Materials and methods

Herds were selected for participation in this study by use of an updated list frame of 2,493 herds designed to include all dairies in California.[5] The list frame was based on results of periodic *Brucella* ring tests recorded with the California Department of Food and Agriculture Animal Health Branch and with USDA:APHIS:VS. For this study, a desired sample size of 30 herds was determined on the basis of results of earlier Califoria NAHMS dairy surveys and considerations of the limitations of field personnel resources.

Survey information was collected from particpating dairy producers by federal and state veterinary medical officers (VMO) who used standarized questionnaires. From the initial interview, farm level data on cattle inventory and general herd management information were obtained. Thereafter, VMO inverviewed participating producers on a monthly basis and recorded information regarding cattle inventory dynamics, herd-wide milk production, and monthly economic inputs and losses related to all health-related problems and their prevention. Producer-maintained records and receipts facilitated the accurate recall of cost information from each herd.

The value of animal deaths, culls, stillbirths, or abortions was estimated by producers as the market value on the basis of breed, gender, and age of an animal, minus any cull value. Anticipated production losses (ie, decreased milk production or weight gain) as a consequence of disease were not estimated. Labor costs were based on the average hourly employee or self-valued wage for each producer. Disease incidence and cost data were compiled for each class of animals in study herds, using the following definitions: calves were aged from birth until weaned off liquid rations; young stock were aged from weaning until sale, first calving (heifers), or first breeding use (bulls); cows were all females that had calved one or more times; bulls were males that had been used for breeding at least once. Each disease event was followed for a 2-week recovery period after diagnosis and treatment, whereupon animals were considered to be at risk for the same disease again; thus, some animals may have been counted more than once for the same health problem.

Each reported health condition or prevention was coded at the most specific level possible, using a standardized hierarchical coding scheme developed for this survey. Each specific condition was then linked to one of 18 categories of clinically similar diseases (Table 1). Cases for which a precise diagnosis was uncertain or not stated were listed directly in the most appropriate disease category, using available information; for example, cases of cows not pregnant were listed in the category of reproductive problems. To reduce the probability of disease misclassification, all analyses were performed by use of the 18 categories. Incorrect specification of the general category of individual disease events was considered to be rare.

Table 1—List of 18 disease categories and primary corresponding diseases used for the National Animal Health Monitoring System (NAHMS) California Dairy Program (1988 to 1989)

Disease category	Specific diseases and conditions included
Diarrhea	All conditions that result in abnormally loose feces
Digestive problems	Displaced abomasum, enteritis, colic, hepatitis, bloat, traumatic reticuloperitonitis, gastric ulcers, strangulated intestine
Diseases of parturition	Abortion, stillbirth, brucellosis, vibriosis, dystocia, mummified fetus
Eye problems	Foxtails in eye, pink eye/keratoconjunctivitis, ocular discharge, eye trauma, ocular squamous cell carcinoma
Lameness	Arthritis, synovitis, leg weakness/abnormal gait, foot rot, limb injury, hip injury, fracture, foot abscess, foot injury, limb trauma, bursitis, laminitis
Multiple systems problems	Infection with *Clostridia* spp, congenital abnormalities, hyperthermia, hypothermia/frostbite, anthrax, thromboembolic meningoencephalitis, poisoning, septicemia, snakebite, bluetongue, bovine viral diarrhea, starvation, injury/trauma, predation
Nutritional deficiencies	Any vitamin, mineral, or trace element deficiency
Oral lesions	Actinobacillosis, actinomycosis, oral lesions
Parasitism (internal)	Parasitic enteritis, anaplasmosis, internal parasitism
Postpartum diseases	Milk fever, retained placenta, obturator paralysis, postparturient toxemia, prolapsed uterus, metritis, downer cow syndrome
Reproductive problems	Infertility, cystic ovary, trichomoniasis, luteal cysts, freemartins
Respiratory diseases	Lung worm, pneumonia, tracheitis, infectious bovine rhinotracheitis, sinusitis, parainfluenza 3 infection, drowning, suffocation, pleurisy, shipping fever, bovine respiratory syncytial virus infection
Skin diseases	Ringworm, warts, lice, skin abscesses, dermatitis, mites, wounds, fleas, ticks, hypoderma
Toxicoses	Grain poisoning, salt poisoning, unspecified types of poisoning
Tumors	All neoplastic processes except ocular squamous cell carcinoma
Udder disease	Mastitis (any cause), udder edema, agalactia, teat injury, udder injury
Undiagnosed disease	All entities for which a more precise diagnosis is uncertain or unavailable
Urinary disease	Renal disease, cystitis, urethritis

For rate calculations, the average monthly number of cattle at risk for disease and preventive medical efforts was estimated for each class of animals from the monthly cattle inventories. Average monthly inventories for each class of cattle were calculated as the mean of beginning-of-month and end-of-month values recorded during producer interviews. Study-wide averages were then determined by dividing the sum of monthly estimates by the total herd-months of observation. Only lactating cows were placed at risk for the category of udder disease. For diseases of parturition and postpartum diseases, the number of cattle at risk was defined as the sum of all calving events (live, aborted, or stillborn) during the study period. Because inadequate information was available to differentiate the reproductive status of young stock, only adults (cows) were considered to be at risk for reproductive problems.

A microcomputer-based relational database software program[a] was used for data management. The Wilcoxon rank sum test[6] was used to compare groups at an α level of 0.05. An estimate of the statewide total milk production and its associated 95% confidence interval was calculated from the total of monthly values, as described.[7]

Results and Discussion

Fourteen dairy producers were selected and recruited by simple random sampling from the list frame. An additional 15 herds were recruited from neighbors of producers that had declined to participate, providing a total of 29 herds for the study (Fig 1). Interviews were conducted between April 1988 and May 1989. All but one of these 29 herds contributed data for an entire 12-month period, for a total of 342 herd-months of observation. During this time, 13,254 cases of disease were reported to have cost $1,355,467, of which 78% was attributable to death and culling losses. An additional $168,091 was spent for disease prevention, for a total of $1,523,558 for health-related expenses in all herds during the year. The average monthly herd size was 680 head, including approximately 297 lactating cows/herd-month of observation. The average milk production per lactating cow was 691 kg/mo, with milk valued at $10.80/cwt, on average.

[a]R:BASE for DOS, Microrim Inc, Redmond, Wash

Figure 1—Geographic distribution of 29 California dairy herds participating in the 1988 to 1989 National Animal Health Monitoring System.

Schukken et al[8] evaluated the repeatability of dairy interviews and found an average of 13.4% errors/questionnaire when interviews were conducted a second time. The NAHMS interviews were repeated throughout the length of the study, to the extent that the expenses and outcomes of class-grouped inventories and disease events were continuously monitored. Inconsistencies in the data were addressed by VMO and producers on an individual basis as they were noticed. This scheme provided for a thorough error checking system, possibly increasing the validity of the final data set. The high month-to-month agreement between interview data in this study is partly documented by the observation that only 35 (0.26%) reported cases contained unexplainable discrepancies regarding their time of onset; that is, costs were accrued for ongoing health problems in 35 animals that were never involved in incident cases.

Statistically significant differences were not found between the randomly selected herds and substitute herds regarding total milk production, total cost of diseases and preventions, or total number of cases reported, suggesting that these 2 groups could be combined for the purposes of study summaries (Tables 2 and 3).

Private veterinary practitioners diagnosed 18.4% of reported cases; the majority of these cases were classified as diseases in the category of reproductive problems (58%), followed by postpartum diseases (25%) and digestive problems (5%). The VMO made the diagnosis for 4% of the cases, most of which (49%) were classified as respiratory disease. Diagnostic laboratories were used for only 42 cases (0.3%), 39 of which were used to identify a cause for udder disease. Veterinary services were responsible for $54,099 (3.55%) of the overall animal health-related costs in the study, indicating an average expenditure of $1,865/producer annually. This value is slightly higher than the $1,090 found in a national survey conducted by mail,[9] a result possibly attributable to the larger size of California dairies, the failure of dairymen to recognize all health-dollar inputs, or relatively greater spending by California dairy producers. Disease prevention was responsible for $34,834 of veterinary services charges, whereas the remaining $19,265 ($758 administered by nonveterinarians, such as contract hoof-trimmers) resulted from disease treatments. These values excluded costs of drugs administered by veterinarians, when it was possible to separate such costs from services. The majority (61%) of veterinary services in disease prevention resulted specifically from pregnancy diagnosis.

Although only 24 (83%) producers indicated during the initial interview that they regularly called veterinarians for individual case treatment, 27 (93%) producers actually reported such use

Table 2—Summary of disease incidence and associated costs for the top 20 disease categories, ranked by overall cost, for 29 California dairy producers participating in the NAHMS (1988 to 1989)

Disease category*	Age group	No. head at risk	No. of cases	Incidence rate†	Cost of disease events ($)	Cost of disease preventions ($)	Combined cost of disease ($)	Annual cost per head at risk ($)
Udder disease	Cows	8,612	3,169	36.8	339,967	89,374	429,341	49.85
Reproductive problems	Cows	10,268	2,348	22.9	364,528	26,149	390,677	38.05
Diseases of parturition	Cows‡	9,979	945	9.5	113,077	15,271	128,348	12.86
Undiagnosed disease	Cows	10,268	289	2.8	127,249	0	127,249	12.39
Postpartum diseases	Cows	9,979	2,408	24.1	80,246	1,542	81,788	8.20
Lameness	Cows	10,268	528	5.1	72,012	6,924	78,936	7.69
Digestive problems	Cows	10,268	316	3.1	60,502	1,580	62,082	6.05
Diarrhea	Calves	1,617	1,229	76.0§	27,137	9,201	36,338	22.47
Respiratory diseases	Calves	1,617	956	59.1§	28,486	3,444	31,930	19.75
Multiple systems problems	Cows	10,268	71	0.7	23,241	1,190	24,431	2.38
Respiratory diseases	Young stock	7,770	233	3.0	17,428	1,038	18,466	2.38
Respiratory diseases	Cows	10,268	62	0.6	17,282	417	17,699	1.72
Reproductive problems	Young stock	10,268	22	0.2	10,343	979	11,322	1.10
Undiagnosed disease	Young stock	7,770	17	0.2	7,901	0	7,901	1.02
Diarrhea	Cows	10,268	37	0.4	6,975	685	7,660	0.75
Lameness	Young stock	7,770	32	0.4	7,400	5	7,405	0.95
Eye problems	Cows	10,268	88	0.9	6,845	0	6,845	0.67
Tumors	Cows	10,268	7	0.1	4,929	0	4,929	0.48
Multiple systems problems	Calves	1,617	50	3.1	4,256	202	4,458	2.76
Digestive problems	Young stock	7,770	10	0.1	3,735	314	4,049	0.52
All others combined	All groups	...	437	...	31,928	9,776	41,704	...
Totals	All groups	...	13254	...	1,355,467	168,091	1,523,558	...

**See* Table 1 for definitions. †Annual incidence proportion per 100 head at risk. ‡By definition, all first-calf heifers were classified as adults (cows). §High rates reflect repeated bouts per animal and dynamic nature of calf population.

*Table 3—Percent distribution of cost components for the top 20 disease categories, ranked by overall cost, for 29 California dairy producers participating in the NAHMS (1988 to 1989)**

Disease category†	Age group	Death losses	Culling losses	Carcass disposal	Milk loss‡	Treatments and preventives	Labor input	Veterinary services§
Udder disease	Cows	10	51	...	11	24	4	...
Reproductive problems	Cows	...	90	...	...	2	1	7
Disease of parturition	Cows	64‖	20	1	...	6	4	5
Undiagnosed disease	Cows	59	37	...	1	1	1	1
Postpartum diseases	Cows	63	16	1	3	8	5	4
Lameness	Cows	6	74	...	5	6	3	6
Digestive problems	Cows	51	29	...	3	5	4	8
Diarrhea	Calves	48	...	2	...	36	14	...
Respiratory diseases	Calves	67	...	2	...	19	11	1
Multiple systems problems	Cows	72	14	1	2	6	3	2
Respiratory diseases	Young stock	82	4	2	...	7	4	1
Respiratory diseases	Cows	78	12	1	1	4	3	1
Reproductive problems	Young stock	...	91	...	...	1	1	7
Undiagnosed disease	Young stock	94	6	...	...	...	...	...
Diarrhea	Cows	84	...	1	1	10	3	1
Lameness	Young stock	39	57	...	...	1	3	...
Eye problems	Cows	...	96	...	...	1	1	2
Tumors	Cows	24	71	1	...	...	1	3
Multiple systems problems	Calves	85	4	2	...	3	4	2
Digestive problems	Young stock	88	...	1	...	7	2	2
All others combined	All groups	41	29	1	1	14	6	8
Overall distribution	All groups	27	51	0.4	4	11	3	3.6

*Each row sums to 100% of the combined cost of each disease category reported in Table 2. †*See* Table 1 for definitions. ‡Includes milk lost only during period of treatment and withholding. §Combination of disease events and prevention expenses. ‖Of the 64% losses to death, 17% resulted from cow deaths and 47% resulted from calves born dead.

during the study. Twenty-two (76%) producers initially responded that they regularly utilized veterinary expertise for reproductive health examinations. Although the same proportion was observed during this study, 2 herds were found to be different in acutal use of these services. Twenty-three (79%) producers initially reported that they routinely used veterinarians for herd vaccinations, but only 11 (40%) subsequently did so for reasons other than brucellosis prophylaxis. Producers also recognized veterinarians as a source of biologicals and drugs (41%) and for advice on calf management (21%) and herd nutrition (10%), but the follow-up data did not allow evaluation of actual use of these services.

The proportions of attributable expenses and disease rankings for this study agreed with those found in the 1986 to 1987 California NAHMS dairy herd survey.[10] However, the costs of disease events and prevention were somewhat higher for the study

reported here. On a per-herd basis, respective disease costs and prevention costs were $46,740 and $5,796 in this study, compared with $40,674 and $3,991 previously.[10] As experience with NAHMS leads to greater awareness of the spectum of relevant cost components, some of these differences might be explained by improved accounting for health-dollar inputs. Although differences in study design and analysis precluded detailed comparisons, our results also seemed to agree with those of Miller and Dorn in Ohio,[11] together suggesting that approximately 89% of health-related expenses arose from disease events and 11% from disease prevention.

One method of evaluating surveys is to compare the resulting estimates to those from recognized reference sources. For this purpose, the annual statewide whole milk production estimated from NAHMS data (6.6 billion kg) was compared with that reported by the California Department of Food and Agriculture over the same period (8.25 billion kg).[12] Their value was located within the 95% confidence interval of the NAHMS estimate, demonstrating the lack of a statistically significant difference. Although this argues favorably for the representative nature of participating herds, at least with respect to milk production, no statewide surveys exist beyond NAHMS with which to compare disease incidence and costs in California. Furthermore, the errors in monitoring herd-wide milk production are probably minimal in comparison with the limited diagnostic framework of the NAHMS study design and the difficulties in assessing true economic losses. McInerney[13] said that such losses are unlikely to be reliably measured by traditional accounting exercises, a situation apparently compounded by problems in defining the components that should be measured.

The health-related expenditures reported by this survey are intended to estimate only the overt costs of disease in California dairy herds, whereas the true costs are undoubtedly much greater because of subclinical disease and other factors. One apparent source of cost underestimation was the failure of producers to recognize the disease-dependent nature of some cows culled for poor reproductive performance, and the reporting of such cases as typical (nondiseased) management culls instead. This is an area that requires careful attention in future NAHMS surveys.

The NAHMS approach attempts to study random samples of herds to provide estimates that are less biased than those previously available. If extrapolations from these data are reasonable, then the statewide combined cost of overt disease to California dairy producers during 1988 to 1989 was approximately $116 million, $1.66 million of which was attributable to veterinary services. To the extent that NAHMS results are representative of each participating state, NAHMS surveys can be combined to form nationally meaningful estimates, thereby contributing usefully to the accurate economic assessment of livestock diseases throughout the United States.

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